APPENDIX A

TERRESTRIAL BIOLOGICAL SURVEY

PUNA GEOTHERMAL VENTURE STUDIES

PUNA, HAWAII

By

Winona P. Char

and

Maile Stemmermann

For

BECHTEL GROUP, INC.
(Environmental Coordinators)

THERMAL POWER CO.

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TABLES

SUMMARY

Thermal Power Company (TPC) is conducting one of several environmental studies for Puna Geothermal Venture (PGV). PGV is investigating the feasibility of potential geothermal power plants on the PGV property.

A 1-mile radius area (approximatey 2,010 aacres) was surveyed for terrestrial plants and animals during January 1984. The data gathered during this field survey provides the basis fo descriptions of the major biological components found within the study site as well as a comprehensive species' list.

No rare, threatened, or endangered species of plants were found on the proposed well and power plant sites. Little or no damage to the vegetation in the area is expected if an effective scurbber system is employed. However, a yearly monitoring program of the vegetation for toxic agents is recommended.

The endangered Hawaiian Hawk (Buteo solitarius) was observed near the proposed well and power plant sites. The hawks may nest in the forests on Pu'u Honua'ula near the KS-2 site. Further observations to determine the extant of hawk breeding near this area are recommended.

BOTANICAL SURVEY

GEOTHERMAL VENTURE STUDIES

INTRODUCTION

Thermal Power Company (TPC) is conducting one of several environmental studies for Puna Geothermal Venture (PGV), Puna, Hawaii. PGV is investigating the feasibility of a potential geothermal power plant on the PGV property within the Puna geothermal resource area, located approximately 20 miles southeast of Hilo, Hawaii. For the purposes of this biological study, a one-mile radius area (approximately 2,010 acres) was selected to be surveyed for the presence of terrestrial plants and animals and threatened or endangered species.

A field survey of the study area was conducted in January 1984. Descriptions of the major vegetation types within the study area as well as a comprehensive floristic species checklist were prepared.

One candidate endangered or threatened species -- Tetraplasandra hawaiiensis -- was found. Three rare species of Cyrtandra and a Bobea species (possibly Bobea timonioides, the plant lacked flowers or fruit) were also found during the course of this survey. None of these species occur on the well or power plant sites.

The Puna District represents one of the geologically younger portions of the island of Hawaii. The Kilauea east rift zone runs the width of the district. Lava flows of different ages can be found throughout the rift zone. The different native vegetation types found on these lava flows reflects the various stages of plant succession which have taken place. On the 1955 Lava Flow the vegetation consists of scattered low stature Metrosideros polymorpha ('ohi'a) with a solid carpet of the whitish-grey lichen Stereocaulon volcani on the ground. On lava which is geologically recent and not deeply weathered the dominant vegetation type

is an open Metrosideros forest with almost a solid mat of Dicranopteris emarginata (uluhe) as groundcover. This type of forest covers large areas in Puna. Where the lava flows are older and deeply weathered, a tall stature closed Metrosideros forest with well-developed shrub and herb layers can be found. These closed Metrosideros forests contain a large number of native species.

Large areas of the Puna District support a number of agricultural activities. Until recently sugar cane was one of the main crops grown in this district. With the close of the Puna Sugar Company, many of the fields have been abandoned or turned over to papaya cultivation. Papaya fields now make up much of the cultivated areas. Other crops such as macadamia nuts, bananas, guavas, and ornamental or nursery plants are also grown in the district.

LITERATURE SURVEY

To my knowledge there has been no prior botanical reports that deal specifically with the entire 2,010 acres of the project area. However, there have been reports which included large portions of the project area or dealt with land adjacent or near to the project area.

The Hawaii Geothermal Project (HGP-A well) is located in the southwest portion of the study area on part of the 1955 Lava Flow. An environmental impact statement (EIS) was prepared for this project (Kamins 1978). Although an area within a mile of the drill site was examined, the examination was cursory and did not involve detailed botanical reconnaissance, transects, and a species checklist. Short descriptions of the dominant vegetation types present within one mile of the HGP-A well were made. The most commonly occurring vegetation type in the area was the 'ohi'a (Metrosideros) forest. For the well site itself, a short list of the plant species present is given. No threatened and endangered plants were believed to be present within the well site.

A series of publications dealing with geothermal development in the State of Hawaii (Siegel 1979-1980) did focus briefly on the flora near the HGP-A well.

A number of botanical surveys in portions of the study area were conducted by Ecotrophics (1981a, 1981b, 1982) during studies to assess any changes in the toxic materials uptake by plants or soils following the operation of the HGP-A Facility. The botanical survey by Lamoureux and Williams (in Ecotrophics 1982) provides good descriptions of the vegetation types as well as a comprehensive checklist of the species present in or near the study area. One proposed threatened plant species, Tetraplasandra hawaiiensis, was found during the survey.

The Halepua'a Forest Reserve is located north of the study area. In a survey of the forest reserve by Clarke et al (1979), nine major and four minor vegetation types were described and data were collected on rare, threatened and endangered species. Pockets of a new Cyrtandra species, as yet unde- scribed, were found in the cracks and gullies throughout the native vegeta- tion. Large trees of Tetraplasandra hawaiiensis were also infrequently found.

About one-third of the study area is covered by the 1955 Lava Flow; much of this area is now under papaya cultivation. The 1955 eruption began on February 28 in the study area near the KS-1 and KS-2 well sites. Four short rows of lava fountains played along the fissures that ran in an east-northeastward direction between the Pahoa-Pohoiki Road and the south base of Pu'u Honua'ula. A brief summary of the events of the 1955 eruption can be found in MacDonald and Abbott (1970). After volcanic activities subsided a study was made of plant succession on the lava flow. Plots were established primarily at the Kama'ili and Ki'i sites. Studies by Doty (1967, 1972) and Doty and Mueller-Dombois (1966) showed that on new lava flows there is a succession of blue-green algae, lichens, mosses, ferns and flowering plants. The pioneer communities ameliorate and stabilize conditions by holding water at the surface where

it leads to evaporational cooling, and by producing shade. In time a herbaceous ground cover and an admixture of tree and shrub species begin to appear on the older, weathered lava.

METHODOLOGY

The objectives of the botanical survey were to:

1. Identify and map the major vegetation types present within the study area.
2. Determine the occurrence of federal and state designated, proposed or candidate threatened and endangered species within the study area.
3. Provide data sufficient for inclusion in a future Environmental Impact Statement to be prepared by others.

Prior to undertaking the survey, a search of the pertinent literature was made to familiarize the investigators with previous studies conducted in the area.

A team of three botanists conducted the field survey during the five-day period from 26 January to 30 January 1984. A total of 15 man-days were required to gather the technical data contained in this report.

Tentative vegetation types delineated from recent aerial photographs were ground checked and correlated with the photographs. Criteria such as the dominant life form, the associated plant species, and the canopy cover were used as differential characters in identifying each vegetation type. Each vegetation type was described by structure and floristics. Three strata were identified -- the tree layer, shrub layer, and herb layer. A visual estimate of abundance was made for each species within each of the different vegetation types.

Areas which were less disturbed were intensively surveyed since rare species are most likely to occur in such situations. The two drill sites, the areas designated for the proposed geothermal facilities, and the immediate areas with native plants, such as Pu'u Honua'ula and several scattered Metrosideros forests near cracks, were intensively surveyed since these areas would be impacted directly or indirectly by the proposed geothermal operations.

Species identification was made in the field. Plants which could not be positively identified were collected for later determination in the herbarium and laboratory. Whenever rare, threatened or endangered species were encountered, their location was mapped as accurately as possible and notes were made on their distribution, physiological condition, and habitat. Voucher specimens were also prepared. These vouchers will be deposited in the herbaria at the Bishop Museum and the Botany Department, University of Hawaii.

RESULTS

A total of 240 plant species were found during the course of this survey; of these, 163 (68%) are introduced species, 65 (27%) are native species, and 12 (5%) are of Polynesian introduction. Of the 65 native species recorded, 33 are endemic, that is, they occur naturally only in the Hawaiian Islands.

Several rare endemic species found in the study area include the three Cyrtandra species, Tetraplasandra hawaiiensis, and a Bobea species (Figure 1). None of these species occur on the proposed well and power plant sites.

Nine vegetation types are recognized within the study area and are described below. Much of the study area has been modified by human activities and consists of cultivated and fallow fields. Of the native

vegetation types, the open Metrosideros forests occupies the most area, however, this vegetation type is not as species rich or diverse as some of the other native vegetation types.

Vegetation Types

Cultivated Areas -- Designated as "C" on the vegetation map (see Figure 3-5 inside back cover).

The cultivated areas present a mosaic of different crops, stages of cultivation, and various human activities. A network of paved and unpaved roads criss-cross the fields. Papaya (Carica papaya) is the main crop grown in the cultivated areas. A few banana (Musa X nana) fields, one field of vanda orchids (Vanda teres X V. hookeriana), and one weedy plot of macadamia nut trees (Macadamia ternifolia var. integrifolia) were also observed.

The papaya fields are in various stages of cultivation. Younger fields have plants a meter high while older fields have plants 2-2.5 m high. Weedy growth is found primarily along the unpaved roadsides and consists of exotics commonly associated with cultivated areas. The most commonly encountered weedy species are a number of Euphorbia species, Lindernia crustacea, Ageratum conyzoides, Borreria sp., Polygala paniculata, Hyptis pectinata, and Cyperus brevifolius. Some of the papaya fields are frequently herbicided.

Scattered throughout the cultivated areas are a number of packing and equipment sheds. A cluster of homes can be found in the northeast section of the papaya fields.

Fallow Fields -- Designated as "C(f)" on the vegetation map (see Figure 3-5).

Certain portions in the cultivated areas have remained fallow for a long period of time and can be characterized as open, grassy areas with scattered shrubs. These fallow fields can be delineated on the aerial photographs.

Many of these fallow fields are abandoned sugar cane fields and plants of sugar cane (Saccharum officinarum) are still frequently encountered. Molassesgrass (Melinis minutiflora) and Californiagrass (Brachiaria mutica) form the dominant cover. Often these two grasses will be found intermixed with Desmodium sp., Desmodium cajanifolium, and sensitive plant (Mimosa pudica). Scattered shrubs of pluchea (Pluchea odorata) and guava (Psidium guajava) are common. Smaller shrubs such as Jamaica vervain (Stachytarpheta jamaicensis), comb hyptis (Hyptis pectinata), and Buddleja asiatica are also frequently found.

Closed Metrosideros Forest -- Designated as "CM" on the vegetation map (see Figure 3-5).

Closed Metrosideros forests can be found on Pu'u Honua'ula, around the large cracks scattered throughout the cultivated areas, in a few parts of the Leilani Estates, and near Pu'u Pilau. These forests are usually found on very old aa lava and are structurally well-developed.

The closed Metrosideros forest consists of tall stature Metrosideros polymorpha ('ohi'a), 20-30 m tall; canopy cover is greater than 60%. The shrub layer, 2-5 m tall, usually consists of a mixture of native and exotic species although in some closed forests the native elements such as Psychotria hawaiiensis (kopiko) may be dominant. The most abundant native species in this layer are the tree ferns, Cibotium glaucum and Cibotium chamissoi. Other native shrubs include lama (Diospyros ferrea), kopiko (Psychotria hawaiiensis), kolea-lau-niu (Myrsine lessertiana), and hame (Antidesma platyphyllum). The most frequently occurring exotic shrubs are strawberry guava (Psidium cattleianum), guava (Psidium guajava), and Malabar melastome (Melastoma malabathricum). Usually these

exotic shrubs are thicker near the edges of the forest. Ground cover is roughly 70% and consists of a mixture of grasses such as Sacciolepis indica, Paspalum conjugatum, Oplismenus hirtellus, etc., and ferns such as Nephrolepis exaltata and Christella dentata.

The epiphytic community is well-developed in this forest type. Vines of ie'ie (Freycinetia arborea) and pi'ia (Dioscorea pentaphylla) are frequently found climbing up the trunks of 'ohi'a trees. Ferns and fern allies such as bird's-nest fern (Asplenium nidus), Vittaria elongata, 'ekaha (Elaphoglossum crassifolium), Lycopodium phyllanthum, and moa (Psilotum nudum) are occasionally encountered.

The ground under the closed Metrosideros forest is damp and the rough aa blocks are covered with the moss Rhizogonium spiniforme.

The greatest number of native species occur in this vegetation type. Several rare or uncommon native species such as the three Cyrtandra species, Tetraplasandra hawaiiensis, and the delicate filmy ferns Mecodium recurvum and Gonocormus minutus occur in the damp cracks and crevices of the closed forest.

Open Metrosideros Forest -- Designated as "oM" on the vegetation map (see Figure 3-5).

The open Metrosideros forest occurs on relatively young, not deeply weathered, lava flows. This vegetation type occupies large areas within the study area such as the northern section above the Pahoa-Kapoho Road (Halekamahina), Leilani Estates, and the southern section along the Pahoa-Pohoiki Road.

The open Metrosideros forest is composed of medium stature, 5-16 m tall, widely spaced trees; canopy cover varies from 20-30%. An almost impenetrable mat of uluhe (Dicranopteris emarginata), 1-2.5 m tall,

covers the ground. Shrubs of Myrsine lessertiana, Pluchea odorata, Psidium guajava, and Melastoma malabathricum are also widely scattered throughout the uluhe tangle.

In places where the uluhe is thin, plants of Andropogon virginicus, Styphelia tameiameiae, Arundina bambusifolia, and Macharina mariscoides are frequently found.

Open Metrosideros-Lichen Forest -- Designated as "oM(S-L)" on the vegetation map (see Figure 3-5).

Part of the 1955 Lava Flow is included in the study area. The vegetation on the lava flow is characterized by an open (5-20% cover), low stature (1-4 m tall) Metrosideros forest or woodland with a ground cover composed of the whitish-grey colored lichen Stereocaulon volcani and the moss Campylopus exasperatus. The hairy swordfern, Nephrolepis multiflora, is abundant in the many cracks and crevices which occur in the pahoehoe lava. Scattered shrubs of pukiawe (Styphelia tameiameiae), pluchea (Pluchea odorata), and Buddleja asiatica as well as grasses such as broomsedge (Andropogon virginicus) and bush beardgrass (Andropogon glomeratus) can be found on the more weathered parts of the lava flow. Young plants of Metrosideros, 14-28 cm tall, are also common to fairly abundant on the lava flow.

Some parts of the lava flow are spongy, filled with air pockets, and brittle, as well as dangerously sharp. Walking on this type of material was difficult as the substrate quickly collapsed underfoot.

The lava fields near Hinalo Road have been bull-dozed and the vegetation cover is slightly denser and consists of a greater number of weedy species. The Metrosideros trees are shorter (0.5-2 m tall) and are more widely scattered than on the undisturbed pahoehoe and aa lavas.

Open Metrosideros/Diospyros Forest -- Designated as "oMD" on the vegetation map (see Figure 3-5).

This vegetation type was only observed on the west slopes of Pu'u Honua'ula. Lama (Diospyros ferrea) is co-dominant with Metrosideros although in some parts of this forest lama forms almost pure stands with only a few scattered Metrosideros trees. Canopy cover is less than 60%. Several large trees of Myrsine lessertiana, 8-10 m tall with basal diameters of 30-35 cm, were found in this vegetation type. Scattered trees of Pandanus odoratissimus are also occasionally found in this forest. Many species found in the open Metrosideros-Psidium forest are also present here. The shrub layer is a mixture of exotic species such as Psidium guajava, Psidium cattleianum, Melastoma malabathricum, etc., and native species such as Psychotria hawaiiensis and Myrsine. The ground cover is a mixture of grasses such as Sacciolepis indica and Oplismenus hirtellus, seedlings of the shrub and tree species mentioned above, and smaller shrubs such as Stachytarpheta jamaicensis and Rubus rosaefolius.

Two species of Cyrtandra as well as three large trees of Tetraplasandra hawaiiensis were found in this vegetation type.

Open Metrosideros-Psidium Forest -- Designated as "oM-P" on the vegetation map (see Figure 3-5).

This vegetation type can be found in some areas north of the Pahoa-Kapoho Road, on Pu'u Honua'ula and its smaller adjacent pu'u (spatter cone), and in some areas near Pu'ulena Crater.

The open Metrosideros-Psidium forest is composed of medium to tall stature Metrosideros ('ohi'a) trees, 8-20 m tall, with canopy cover varying from 20 to 50%. Scattered trees of Diospyros ferrea (lama), Aleurites moluccana (kukui), Cecropia obtusifolia (guarama), and Melochia umbellata (melochia) are occasionally found. Tall Psidium cattleianum

(strawberry guava) and Psidium guajava (guava) form a distinct subcanopy layer. The two species of Cibotium (tree ferns), Sadleria cyatheoides ('ama'umau), Myrsine lessertiana (kolea-lau-niu), and Melastoma malabathricum (Malabar melastome) are common components of the shrub layer. The ground cover is a mosaic of plant associations. In areas where the canopy is more open patches of uluhe (Dicranopteris emarginata) or broomsedge (Andropogon virginicus) can be found. In areas where the canopy is denser the ground cover may consist either of a mixture of shade-tolerant grasses such as basketgrass (Oplismenus hirtellus) and Hilograss (Paspalum conjugatum), smaller shrubs such as thimbleberry (Rubus rosaefolius), and seedlings of the tree and shrub species or the ground cover may be dominated by ferns such as Christella dentata (oak fern) and Nephrolepis exaltata ('okupukupu).

The epiphytic community in this vegetation type is also well-developed. Plants of Pleopeltis thunbergiana, Asplenium nidus, Ophioglossum pendulum, and Elaphoglossum crassifolium are often found on the 'ohi'a trees.

All three Cyrtandra species as well as Tetraplasandra hawaiiensis and the Bobea sp. were found in this vegetation type.

Mixed forest -- Designated as "mf" on the vegetation map (see Figure 3-5).

This vegetation type is a mixture of Metrosideros and exotic trees -- Albizia falcataria, Cecropia obtusifolia, Melochia umbellata, Eugenia jambos (rose apple), and Mangifera indica (mango). A few kukui trees (Aleurites moluccana) are also frequently found in these forests. In the study area this vegetation type is often found bordering the roadsides. Along the Pahoa-Pohoiki Road almost pure stands of Albizia up to 30 m tall can be found.

The mixed forest is a medium to tall stature forest (10-30 m tall), and canopy cover is usually greater than 60%. The shrub layer may consist of scattered shrubs if the canopy cover is thick or fairly dense shrubs if the canopy cover is thinner. The shrub layer is composed most commonly of the two Psidium species, Leucaena leucocephala (koa-haole), Pluchea odorata (pluchea), Melastoma malabathricum (Malabar melastome) and the native shrubs Psychotria hawaiiensis (kopiko) and Pipturus hawaiensis (mamaki). Young saplings of the tree layer species are also numerous. Ground cover is a mixture of grasses such as Melinis minutiflora (molassesgrass), Brachiaria mutica (Californiagrass), and Pennisetum purpureum (Napiergrass), smaller shrubs such as Coleus blumei (coleus), Rubus rosaefolius (thimbleberry), and Stachytarpheta jamaicensis (Jamaica vervain), herbs such as Borreria sp., Begonia sp., and Mimosa pudica (sensitive plant), and ferns such as Christella dentata (oak fern) and Nephrolepis multiflora (hairy swordfern).

Scrub or Ruderal Community -- Designated as "S" on the vegetation map (see Figure 3-5).

The scrub or ruderal community is found in areas which are frequently disturbed or have been cleared such as along roads and trails, near the powerlines east of Lava Tree State Park, and along forest borders. These sites are usually dominated by a number of weedy shrubs and grasses.

This vegetation type may vary from open, grassy areas with scattered shrubs (5-10% cover) to more or less dense shrub cover (60-70%), 1.5-6 m tall. Andropogon virginicus, Melinis minutiflora, and Brachiaria mutica form the dominant grass cover while the most commonly occurring shrubs are the two Psidium species, Pluchea odorata, and Melastoma malabathricum. Several plants of Clidemia hirta, a noxious weed, were found across the road from the Kapoho Electric Substation near pole #313.

A number of scrub thickets found in the cultivated and fallow fields are lumped under this vegetation type. These thickets apparently were left undisturbed by the farmers to serve as windbreaks. They appear as long, narrow bands across some of the fields. These thickets may be up to 6 m tall, are very dense, and are composed primarily of shrubs such as Pipturus hawaiensis, Pluchea odorata, Buddleja asiatica, and small trees of Trema orientalis and Melochia umbellata.

The area east of the powerlines near the Lava Tree State Park appears to have been disturbed at one time. The vegetation is open and consists of 1-6 m tall, scattered 'ohi'a with 5-10% cover, patches of Andropogon (30-40% cover), and Melastoma-Dicranopteris thickets (20-30% cover).

LIMITATIONS OF THE SURVEY

The species recorded are indicative of the season and environmental conditions at the time of the survey. A survey taken at a different season and under varying environmental conditions would no doubt yield slight variations in the species list and in abundance ratings especially of the annual species. Woody species have been censused to a greater degree of reliability.

Intensive field surveys were conducted in areas where there was a high likelihood of finding important native plant species and in the sites proposed for future geothermal facilities since these sites would be directly impacted by construction activities. Surveys were not conducted as intensively in the cultivated and fallow field vegetation types as these areas are dominated by exotic plant associations. Thus a few obscure weedy species may have been omitted from the plant checklist.

Boundary locations of the different vegetation types may vary slightly as these are based on simple field mapping techniques and field interpretation of map contours and the quality of the aerial photographic signatures.

Overall, the basic limitations of this survey are not believed to be significant in terms of the objectives and findings of this survey.

RECOMMENDATIONS

This portion of the report is divided into three sub-sections which deal with impacts on the existing vegetation which will occur during clearing and construction activities; operation of the power plant and production wells; and shutdown of the power plant and wells. Possible mitigation measures which will reduce the adverse impacts on the vegetation during the various phases of construction and operation activities are proposed.

Clearing and Construction Impacts

An intensive survey was made of the well sites and proposed power plant and facilities sites. These sites are situated on fallow fields, scrub vegetation or cultivated areas. Exotic, weedy species make up the dominant vegetative cover in the uncultivated areas while papaya plants occur extensively throughout the cultivated areas. Those native species which do occur on the proposed well and power plant sites are not considered rare, threatened or endangered and are found throughout the Puna and neighboring districts. Construction at the proposed sites will have no significant impact on the total island populations of the plant species present at these sites.

Removal of vegetative cover will lead to some loss of soil through wind and water erosion. However, the erosion hazard potential of this area has been rated "Slight" by the U.S. Department of Agriculture, Soil Conservation Service (1975). Much of the substrate in the study area contains little soil and consists of land classified as rCL- cinder land, rLV- lava flows aa, rLW- lava flows pahoehoe or rOPE - Opihikao, extremely rocky muck (USDA 1973).

During well drilling and testing potentially large amounts of H_2S could be released into the atmosphere along with the steam. Effective control methods can remove as much as 90% of the H_2S (Dames and Moore 1984). The possible negative impacts on vegetation are discussed in the following subsection.

Operation of the Power Plant and Production Wells

Liquid waste will be reinjected into a deep well and will thus pose no hazards to the vegetation. Gases and condensation from the cooling tower will be emitted into the surrounding atmosphere. Steam would be vented during periodic maintenance cleaning or if a breakdown should occur.

The noncondensable gases present may include carbon dioxide (CO_2), hydrogen sulfide (H_2S), ammonia (NH_3), nitrogen (N_2), hydrogen (H_2), methane (CH_4), ethane (C_2H_6), and helium (He). Usually CO_2 and H_2S are the predominant gases while the other gases are present in only minor amounts (Dames and Moore 1984). Studies of the HGP-A well have found a high content of H_2S, low CO_2 content, and no NH_3. The noncondensable gas content at HGP-A is almost one half that of the Geysers systems (Dames and Moore 1984).

An effective scrubber system, such as an incinerating-scrubbing system, has a removal efficiency greater than 99%. The overall H_2S removed at the HGP-A facilities is 98% (Thomas 1982). If an effective scrubber system is employed toxic emissions from the proposed operations should be minimal and theoretically there should be little or no damage to the surrounding vegetation. Data collected during yearly moniterings of the vegetation and plant tissue analysis around the HGP-A site and the adjacent areas (Ecotrophics 1981a, 1981b, 1982) have shown no significant increases in toxic emissions such as mercury (Hg) or arsenic (As). These findings, however, are based only on short-term observations.

It is recommended that the yearly monitoring program of the surrounding vegetation be continued. In a conference on the environmental aspects of geothermal resource development (Anderson and Bowen 1974) it was recommended that a continued, long-term monitoring of a geothermal plant to be done to determine whether any significant increases in toxic agents occurred. Data from other geothermal projects may not be applicable to the PGV project since geothermal plants very in kinds and quantities of substances emitted.

A direct, relatively short term negative impact on the vegetation would occur if there should be a total breakdown of the emission control systems. Tissue damage would begin to appear on the surrounding vegetation especially on the cultivated crops. However, for this to occur would require that the steam be vented for some period of time and that the trade-winds (which would normally disperse the steam very quickly) be weak or absent.

Shutdown of the Power Plant and Wells

No negative impacts are expected. The vegetation on the project site would return to its natural state if not maintained. Weedy species would invade the site and a ruderal community composed of grasses such as Melinus minutiflora, shrubs such as Pluchea odorata and Psidium guajava, and herbs such as Borreria sp. and Desmodium cajanifolium would soon occupy the site.

BIRD AND MAMMAL SURVEY

INTRODUCTION

The Puna Geothermal Resource area has been the focus of keen interest on the part of potential geothermal investors and developers since the demonstration of a proven resource in the region by the HGP-A well at Pohoiki. Two wells have been drilled in the vicinity of Pu'u Honuaula (north of the Pohoiki wellsite) by Puna Geothermal Ventures. The report that follows is the result of a faunal survey performed for PGV prior to activation of either of their wells.

The purpose of the survey was to provide a faunal survey of the area around the PGV wellsites adequate for inclusion into future Environmental Impact Statements necessary for well activation and associated activities.

LITERATURE SURVEY

In spite of its inclusion within the Puna Geothermal Resource Area, the 2010 acre site under consideration has yet to be well surveyed for birds or mammals. Early records of observers and naturalists who may have worked in the region are poorly documented with regards to specific sighting or collecting localities (e.g. Perkins, 1896). No specific faunal surveys for this region were completed for this region before 1976. At that time Dr. A. J. Berger completed a brief ornithological survey in conjunction with the planning and EIS for the HGP-A well complex (see Kamins et al., 1976, Kamins, 1978). He found seven bird species in the area as follows: Streptopelia chinensis (Spotted Dove), Garrulax canorus (Melodius Laughing-thrush), Zosterops japonicus (Japanese White-eye), Acridotheres tristis (Common Myna), Carpodacus mexicanus (House Finch), Lonchura punctulata (Spotted munia), and Cardinalis cardinalis (Northern Cardinal). Berger found no evidence of the two native endangered bird species that may occur in the area, the Hawaiian Hawk (Buteo solitarius) and the Hawaiian Owl (Asio flammeus)), nor was he able to find any past records of either species in the area.

Studies of the biology of the Hawaiian Hawk in the Puna area have shown that lower elevation portions of the Puna District are intensively utilized by this species for both nesting and feeding (C. Griffin, pers. comm.). However, their presence was noted in the nearby Nanawale Forest Reserve during a botanical survey of that area performed by the State of Hawaii Department of Land and Natural Resources.

The HGP-A EIS also mentioned the presence and abundance of rats in the area, although no species were specified (Kamins, 1978). Mongoose (Herpestes auropunctatus) were also found abundantly. There have been no published records of the rare Hawaiian Hoary Bat (Lasiurus cinerius) for this area, nor were they found in the 1978 EIS.

METHODS

Two and one half days of field work were performed in the study site of a circle of 1 mile radius centered on Pu'u Honua'ula, Puna, Hawaii between January 24 and February 12, 1984. The majority of work was done between the hours of 7:30 am and 5:00 pm, but 2 1/2 hours were spent during the evening hours (6:45 pm-7:30pm) searching for nocturnal species such as owls and bats.

Bird censuses were conducted using either Emlen's (1971) transect count method or Ramsey & Scott's (1979) variable circular plot method. Sighting locations were recorded for rarer species less likely to be detected during an official census period (e.g., for 'I'o, Pueo, or Barn Owls).

Due to the limited amount of suitable bird habitats in the study area (much of the habitat consisted of barren lava or agricultural fields in varying stages of cultivation and disuse), more field time was concentrated in the small areas of forest at Pu'u Honua'ula and surrounding areas. Special attention was paid to habitats likely to

harbor native bird species such as 'I'o; Kipukas in agricultural areas were extensively surveyed, as was Leilani Estates forest, and the forest between Lava Trees State Park and the Kapoho-Pahoa Road.

No specific work was performed to determine the presence or abundance of exotic mammals in the area. Qualitative, observational methods were used for these species including direct observation, observation of damage to agricultural crops, and indirect observations of scat and spoor. Evening surveys for the native Hoary Bat were performed from road access into the study area and entailed scanning suitable habitats for foraging bats.

RESULTS

Birds

Eleven bird species were found in the study area, comprising members of nine avian families. Only two of these species were native (the Hawaiian Hawk, and the Lesser Golden Plover), the rest were exotic.

Table A-1 summarizes the species present and their approximate densities, expressed as relative abundances, in the study area. Table A-2 pools the separate census results, and presents distributions of bird species found in the different habitats. An annotated species' list follows; detailed information on each species is provided. A separate table is provided for native species not observed during this survey but are known to be present in other parts of lower elevation Puna District (Table A-3).

Nomenclature and phylogenetic order for Tables A-1 and A-2 and for the annotated checklist follow the American Ornithologist's Union Checklist of North American Birds, 6th Edition (1983) and Pyle's (1977) Preliminary Checklist of the Birds of Hawaii.

Table A-1

Bird Species Occurring in the Pu'u Honua'ula Region

Family	Species (Scientific/Common Name)	Status [1]	Density in Study Area [2]
Accipitridae	Buteo solitarius; Hawaiian Hawk, 'I'O	Re,E	U
Charadriidae	Pluvialis dominica; Lesser Golden Plover, Kolea	Vr	U
Columbidae	Streptopelia chinensis; Spotted Dove	Fl	R
	Geopelia striata; Barred Doved	Fl	R
Tytonidae	Tyto alba; Barn Owl	Fr	Occ.
Timaliidae	Garrulax canorus; Melodius Laughing-thrush	Fl	U
Zosteropidae	Zosterops japonicus; Japanese White-eye	Fl	A
Sturnidae	Acridotheres tristis; Common Myna	Fl	A
Ploceidae	Passer domesticus; House Sparrow	Fl	R
Fringillidae	Cardinalis cardinalis; Northern Cardinal	Fl	C
	Carpodacus mexicanus; House Finch	Fl	A

[1] Status (Symbols after Pyle (1977) Preliminary Checklist of the Birds of Hawaii, 'Elepaio 37(10):112-121.
- Re = resident species; native, endemic at the species level
- Fl = foreign introduced species, long established & breeding in Hawaii (for more than 25 years)
- Fr = foreign introduced species, recently established & breeding in Hawaii (for less than 25 years)
- Vr = Visitor species, breeds elsewhere, regular migrant to Hawaii
- E = currently on the Federal List of Engandered Species

[2] Density (expressed as relative abundance)
- Occ = Occasional
- R = Rare
- U = Uncommon
- C = Common
- A = Abundant

Table A-2

Incidence of Avian Species on Census Counts in Various Habitats of the Study Area

Species	Habitats[1]										
	A	B	C	D	E	K1	K2	K3	K4	F	Total
'I'o				5				1	2		8
Kolea			4	1	3						8
Spotted Dove	1		1							1	3
Barred Dove					1						1
Barn Owl		1									1
Melodius Laughing-thrush	2	1	2	4		1	2	1		3	16
Japanese White-eye	5	11	26	33	3	3	1	12	5	8	107
Common Myna	5	6	7	14	20			9	3		64
House Sparrow			3								3
Northern Cardinal	2	1	8	13	1	2	5	2	4		38
House Finch	11	7	21	41	9	1	2	6	9	1	108
Totals	26	27	72	111	37	7	5	34	18	20	357

[1] Habitats

A = Large-stature exotic forest nr. Lava Trees State Park and along Pahoa-Pohoiki Rd.
B = Ohia forest north of Pahoa-Kapoho Rd.
C = Ohia forest, Leilani Estates
D = Pu'u Honua'ula and smaller Pu'u to its immediate SW
E = Papaya fields (active and inactive) and other agricultural areas in study site
K1 = Small Kipuka (crack) 1/3 mile NE Pu'u Honua'ula
K2 = Small Kipuka (crack) 1/2 mile ESE Pu'u Honua'ula
K3 = Large Kipuka (crack) 1 mile E Pu'u Honua'ula
K4 = Large Kipuka (crack) 1/4 mile WNW Pu'u Honua'ula
F = Pu'ulena Crater

Annotated List of Birds Observed in the Study Area

Accipitridae — *Buteo solitarius*; Hawaiian Hawk, 'I'o

The Hawaiian Hawk is endemic to the island of Hawaii, the only remaining species in a once diverse endemic raptor fauna (Olson & James 1982). This species is on the Federal List of Endangered Species, although its status there is presently being questioned (Mike Scott, USFWS, pers. comm.). Its breeding range encompasses most of the island of Hawaii; the district of Puna is an area with especially dense breeding populations. Of particular importance for the success of the Hawaiian Hawk breeding in Puna are the prime agricultural lands extending South and East of the town of Pahoa, into which the present study area falls.

A relatively high density of hawk was found on this survey (see Table A-3 and Figure 3-1), reflecting the importance of this region for hawk populations. Since the Hawaiian Hawk were censused during the non-breeding season, additional information is necessary to determine the specific importance of the Pu'u Honua'ula site as a breeding area (see Recommendations below).

It is clear from these data, however, that Pu'u Honua'ula is an area which is heavily used for feeding. Hawk were most frequently found perching in the small enclaves of native forest adjacent to papaya fields; these areas included Pu'u Honua'ula itself, the adjacent Pu'u to the west, and two of the long, narrow Kipukas within the study site. Hawk were also seen in flight, both over forested and cultivated areas.

A total of eight hawks were seen over the course of this survey, four birds were seen in 2 pairs, four birds were seen individually. Six of these sightings occurred in one field day. From the variation in coloration of the animals seen ('I'o occur in dark and light color phases), it is clear that there are at least 2, and possibly 3 or 4 separate pairs of birds present in the study area. Further study of this

population during the breeding season (when nests are well-established) would clarify present ambiguity regarding possible repeated sightings of individuals (see Recommendations).

Charadriidae — Pluvialis dominica, Lesser Golden Plover, Kolea

This species of shorebird breeds in Siberia and Arctic North America; wintering populations arrive in the Hawaiian Islands in late August and leave in March and April. On their wintering grounds, individuals are often territorial and are site-tenacious, returning to the same location year after year (Brunner, pers. comm.). The Kolea was widely distributed throughout the study area in fairly small numbers. It was commonest in agricultural fields and in open areas, and found in smaller numbers on subdivision roads.

Columbidae — Streptopelia chinensis, Spotted Dove

This introduced species of dove was found in very low densities in forested portions of the study area, particularly in Leilani Estates and adjacent areas, and in the vicinity of Lava Trees State Park.

Columbidae — Geopelia striata, Barred Dove

The Barred Dove was observed only once in the study area, in papaya fields north of the Pu'u Honua'ula well sites. This species (like the preceeding one) is mostly a seed-eating bird (Schwartz and Schwartz 1949, Berger 1983) and requires a source of drinking water. This factor probably plays an important role in determining the low abundance of both these species in the study area.

Tytonidae — Tyto alba, Barn Owl

The Barn Owl is a relatively recent introduction to the Hawaiian Islands; the first birds were introduced to the Hamakua region of the island of Hawaii in 1958. The primary food of this species in the Hawaiian Islands is small exotic mammals, particularly mice and small

rats (Tomich 1971). One individual of this species was seen soon after dusk on February 11, 1984, adjacent to the Pahoa-Kapoho Road. The Barn Owl probably occurs in low densities throughout the agricultural portions of the study area, though its nocturnal habits prevent accurate density estimation or determination of its distribution.

Timaliidae — Garrulax canorus, Melodius Laughing-thrush

This species was found in low numbers in forested portions of the study area, apparently preferring exotic vegetation to native forest. The Melodius Laughing-thrush was most frequently observed in exotic stands of forest on Pu'u Honua'ula, in Leilani Estates, and in the vicinity of Pu'ulena Crater.

Zosteropidae — Zosterops japonicus, Japanese White-eye

The Japanese White-eye was one of the most common species in the study area. It was found throughout the area in all habitats censused. Lowest densities for this species were seen in papaya fields and other agriculturally-modified habitats. It was found in quite high density in closed forests, both native and exotic, with highest numbers occurring in Leilani Estates and on Pu'u Honua'ula. This species is an omnivore, and much speculation has occurred as regards its possible role in the local extinction of native forest birds through dietary competition (e.g., see Banko 1978, Banko & Banko 1976).

Sturnidae — Acridotheres tristis, Common Myna

The Common Myna was also particularly abundant throughout the study area. Unlike the Japanese White-eye, it showed a marked preference for open areas such as inactive papaya fields as well as areas under cultivation. If found in forested regions mynas were invariably found in cleared areas (e.g., roads) or adjacent to forest edges. This species is known to be commensal with man and does not often stray from developed or impacted areas.

Ploceidae — Passer domesticus, House Sparrow

Another commensal species, this bird was found only in the Leilani Estates section of the study site in very low numbers. Berger (in Kamins 1978) did not find this species in his earlier survey of the Pohoiki region, and it may be newly established here.

Fringillidae — Cardinalis cardinalis, Northern Cardinal

The Northern Cardinal was found in relatively low numbers throughout the study area. This species showed a distinct preference for forested areas (it was very common at Pu'u Honua'ula, less so in Leilani Estates), particularly those with some exotic plant cover. It was found on only one occasion in cultivated fields.

Fringillidae — Carpodacus mexicanus, House Finch

This species was common to abundant in all habitats within the study area and was often found in large flocks of up to 40 individuals. Although primarily a seed eater, the House Finch is renowned for its predilection for papaya and other soft fruits ("papaya bird" is a widespread common name for the species), which explains to some extent its abundance in the study site.

Species of Birds Absent in the Study Area

Table A-3 lists native forest birds presently occurring in other portions of the Puna District (especially areas below 2000 feet elevation) which were not found in the study area despite the presence of suitable habitat. Factors influencing the distribution of these species are many, including the following:

1. Habitat degradation through direct (i.e., clearing of land for agricultural operations, opening of forest tracts for housing, etc.) or indirect (i.e., pig and/or goat damage, exotic plant invasion) means. Decreased area of contiguous habitat.

2. Avian disease, particularly avian malaria.
3. Predation by exotic mammals, particularly cats, mongooses, and rats.
4. Increased human activity concomitant with factor 1.
5. Competition with exotic bird species (e.g. Pueo with Barn Owl, 'Amakihi, 'Apapane, 'Elepaio with Japanese White-eye).

Included in Table A-3 are data from censuses in the Kalapana Extension of Hawaii Volcanoes National Park: lowest known elevations from census counts, and approximate abundance at that elevation. Data from Hawaii Volcanoes National Park should be considered as from a moderately undisturbed ecosystem; factors 1, 2, 3, and 5 are all present to some extent but are not as severe as in the Pu'u Honua'ula area which has been impacted by various kinds of human activity for a number of years. Hawaii Volcanoes data are from Conant (1980).

Table A-3

Bird Species Absent from Study Area

Family	Scientific/Common Name	Low Elevation (HAVO)	Density	Factors Affecting Study Site Distribution[1]
Strigidae	Asio flammeus sandwichensis; Short-eared Owl, Pueo	1200 feet	Rare	H,C
Turdidae	Phaeomis obscurus obscurus; Hawaiian thrush, 'Omao	1600 feet	1-10 birds/40ha	H,C,D[2]
Musicapidae	Chasiempis sandwichensis sandwichensis 'Elepaio	400 feet	11-20 birds/40ha	H[3],C
Fringillidae	Loxops virens virens; 'Amakihi	50 feet	less than 1 bird/40ha	H[4],S[5]
	Psittirostra psittacea; 'O'u'	ca. 2100 feet	Rare (1 individual)[6]	H,R,D,C
	Himatione sanguinea; 'Apapane	400 feet	21-60 birds/40ha	H,R[7]

[1] Distribution factors:
H = Habitat alteration
C = Competition
D = Disease
R = Resource availability
S = Sampling technique

[2] The Thrush occurs commonly well below zones of mosquito infestation, indicating the secondary importance of disease in determining this species' distribution.

[3] High densities of this species are associated with high structural diversity of habitat which is generally lacking in the Pu'u Honua'ula area.

[4] 'Amakihi prefer open dry scrub and forested areas to more mesic habitats (Conant 1980, pers. obs.). They have been found in the Malama Ki Forest Reserve (Puna) at an elevation of 250 feet (Berger 1983).

[5] Conant (1980) indicates greater than usual difficulty in detecting this species from 10:00 a.m. to 2:00 p.m. Because of limited field time available, much of the censusing for birds occurred during these hours.

6 Only one observation at this low elevation in Conant's NPS survey (1980). This species is probably found in lower Puna only as a result of the wide dispersion tendency of these birds from their distributional center, Ola'a Tract at HAVO, 4000 feet. This species requires precise habitat parameters (see Berger 1983), and undisturbed forests; I would not expect it in habitats such as those around Pu'u Honua'ula which have been considerably altered.

7 'Apapane appear to require a certain minimum density of 'ohi'a or a minimum level of nectar availability (Carpenter & MacMillen 1976, Conant 1980, pers. obs.). Presence of 'Apapane in the Pu'u Honua'ula area (if at all) may be sporadic due to fluctuation of resource levels. Reduction of habitat quality in the study area due to invasion of exotic plants may also be a factor affecting this species' distribution. (The latter would affect 'Amakihi and 'Elepaio in a similar manner).

Mammals

There were no observations of the native Hoary Bat in the study site, in spite of two nocturnal visits to the area in search of them. This species preferentially forages along forest edges or over bodies of water (Baldwin 1950); and there is undoubtably suitable habitat of the former variety for this species in the Pu'u Honua'ula area. Published records of bats in the Puna District are non-existent, no doubt due to the difficulty in detecting and observing these small nocturnal mammals.

Other non-native mammals were common in the study area, almost exclusively in agricultural sites. Mongoose were seen and heard consistently in all agricultural habitats, and were especially common in old fields where there was high density of shrubs and weeds for cover. One feral cat was seen in papaya fields adjacent to Pu'u Honua'ula. Rats and mice were evident in active papaya fields thanks to their gnawing of ripe fallen papaya. Four species of rodents are found in these habitats (Kramer 1971). Mus musculus, Rattus rattus, and Rattus exulans are not commonly found in fields, while Rattus norvegicus is found most frequently within 500 feet of human habitations or other structures (Eskey 1934 cited in Kramer (1971)). There was no evidence of feral pig activity in the study site.

RECOMMENDATIONS

Of overriding importance regarding the proposed uses of the study area is the presence of relatively large numbers of the endangered Hawaiian Hawk in the area surrounding the two well sites. As mentioned above (page 5), due to the timing of this survey, no evidence of breeding was found. However, Silva (pers. comm.) of Freeman Guards (who has had 2 years of experience guarding both well sites) reports having seen evidence of breeding (i.e., nests and young birds) at Pu'u Honua'ula in past years. One pair and three single individuals were seen in the same vicinity in this survey; it may be that more than one breeding pair is

present there. Sightings of both pairs and single individuals in other parts of the study area suggest the presence of one or two additional pairs within a one mile radius of well sites.

A survey during the early part of the breeding season (May or June) would not only determine the extent of hawk breeding activity within the study area, but it would also provide a more accurate estimate of total population size than is possible from the present data. The two sightings of pairs around Pu'u Honua'ula are certainly non-overlapping observations since one pair consisted of two dark phase birds and the other contained one light phase individual. The four observations of individuals (three at Pu'u Honua'ula, one at a Kipuka to the east), are more problematic - some of these birds may be members of previously sighted pairs, and it is unclear how many repeat sightings of individual birds occurred. As these birds settle down to breed later in the year, it will become far easier to settle these questions. 'I'o are quite nest-site tenacious (Berger 1983, pers. obs.), and the close observation possible of nesting individuals allows both individual recognition and a very accurate estimate of population size.

Once the size of the breeding hawk population is accurately determined, the question becomes how to best mitigate possible adverse effects of well operations on hawk breeding. Two factors of most concern are the effects of noise during the breeding season, and the effects of fumes from well operations. Unfortunately, there have been no studies on either of these factors on either the Hawaiian Hawk or other members of the genus Buteo on the mainland. While it is generally known that bird species are able to acclimate to moderate amounts of continuous noise (as occurs adjacent to highways, etc.), there is no evidence that this kind of accumulation can occur when noise is sporadic or quite loud (as when a well is vented). Recent observations of Peregrine Falcon breeding biology on the eastern seaboard indicate that some raptors are able to breed under extremely noisy conditions; several pairs in the New York City area were nesting on bridges, either on ledges under the roadbed or

elsewhere on towers (Peregine Fund Newsletter, March 1984). Whether 'I'o are as adaptable is an open question. My own observations of this species indicate that they are remarkably oblivious to simple human presence when perching or foraging. However, observations of other biologists on other species of nesting raptors do not confirm this observation during the breeding season (Suter 1978).

Of potentially greater harm to breeding birds in the area are the effects of well emissions. This is a subject of ongoing controversy, as there exists no clear evidence showing either adverse effects or lack thereof. As experimentation is impossible in this case, it is probably better to first assume adverse effects and to take all possible mitigating measures. These include installment of effective abatement equipment (i.e., scrubbers, etc.), and possible slow-down of operations during peak breeding months (May-August), or under Kona wind conditions. All sightings of hawk in the area to date have occurred upwind of both wells, so that under normal trade-wind conditions, exhaust gasses will be blown away from possible nest sites. This would change drastically when normal trades fail and winds are out of the South or Southwest. Such conditions frequently occur, particularly in winter months. At such times, fumes (especially from well site 2) would blow directly into an area of high hawk density possibly disrupting both feeding and (if trades fail during summer months) breeding.

If well activation takes place as is presently planned, it would be wise to actively monitor hawk population size and breeding activity from the outset as an ongoing project (e.g., see Lamoureux 1979). By doing so, it will be possible to fairly accurately identify problems as they are occurring and to take proper precautions before permanent damage occurs to hawk populations in the area. Such surveys should be done on a monthly basis during the non-breeding season, and more frequently during the summer months. Surveys should include both censuses of birds known to occur in the area and information on breeding status and success (e.g., clutch size, feeding success, mortality of young, etc.).

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PLANT SPECIES CHECKLIST - Puna Geothermal Ventures Studies

Families are arranged alphabetically within each of three groups: Ferns and Fern Allies, Monocotyledons, and Dicotyledons. Taxonomy and nomenclature of Ferns and Fern Allies follow Lamoureux's unpublished checklist of Hawaiian ferns; taxonomy and nomenclature of the flowering plants (Monocotyledons and Dicotyledons) follow St. John (1973) except where more commonly accepted names are listed. Hawaiian names used in the checklist are in accordance with Porter (1972) or St. John (1973).

For each species the following information is provided:

1. Scientific name with author citation.

2. Common English or Hawaiian name, when known.

3. Biogeographic status of the species. The following symbols are employed:

   E = endemic = native to the Hawaiian Islands only, not occurring naturally elsewhere.

   I = indigenous = native to the Hawaiian Islands and also to one or more other geographic areas.

   P = Polynesian = plants of Polynesian introduction; all those plants brought by the Polynesian immigrants prior to contact with the Western world.

   X = exotic or introduced = not native to the Hawaiian Islands; brought here by man accidentally or deliberately after Western contact.

4. Vegetation types. Nine major vegetation types are recognized within the study area. The number heading each of the columns refers to the following vegetation types:

   1 = Cultivated Areas

   2 = Fallow Fields

   3 = Closed Metrosideros Forest

   4 = Open Metrosideros Forest

   5 = Open Metrosideros-Lichen Forest

6 = Open Metrosideros/Diospyros Forest

7 = Open Metrosideros-Psidium Forest

8 = Mixed Forest

9 = Scrub

Within each of the vegetation type columns the relative abundance of each species (or absence) is given. These ratings are based entirely upon a comparison of the frequency with which a species occurs, as compared to all other species, within the study area. It does not denote, necessarily, the abundance of that particular species in the Hawaiian Islands. The following symbols for relative abundance are used:

A = abundant = generally the major or dominant species in a given vegetation type.

C = common = generally distributed throughout a given vegetation type in large numbers.

L = locally common = found only or principally in one or more restricted areas, although within that area it may occur in large numbers.

O = occasional = generally distributed throughout a major portion of a given vegetation type, but in small numbers.

U = uncommon = observed infrequently but more than 10 times in a given vegetation type.

R = rare = observed 1 to 10 times in a given vegetation type.

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
FERNS AND FERN ALLIES											
ADIANTACEAE											
Adiantum raddianum Presl	Maiden-hair fern	X	-	-	R	-	-	-	R	-	-
ASPLENIACEAE											
Asplenium falcatum Thunb.		I	-	-	U	-	-	-	-	-	-
Asplenium nidus L.	'Ekaha, bird's-nest-fern	I	-	-	U	-	-	R	U	U	-
ATHYRIACEAE											
Athyrium sandwichianum Presl	Hoio	E	-	-	O	-	-	R	U	R	R
BLECHNACEAE											
Blechnum occidentale L.	Blechnum	X	-	-	U	-	-	-	U	-	-
Sadleria cyatheoides Kaulf.	'Ama'uma'u	E	-	-	-	O	U	R	O	U	R
DENNSTAEDTIACEAE											
Microlepia strigosa (Thunb.) Presl	Palapalai, palai	I	-	-	R	-	-	-	U	-	-
DICKSONIACEAE											
Cibotium chamissoi Kaulf.	Hapu'u 'i'i	E	-	-	O	U	-	O	O	-	R
Cibotium glaucum (J.Sm.) H. & A.	Hapu'u	E	-	-	C	U	-	C	C	O	R

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
ELAPHOGLOSSACEAE											
Elaphoglossum crassifolium (Gaud.) Ander. & Crosby	'Ekaha	E	-	-	U	-	-	R	O	-	-
GLEICHENIACEAE											
Dicranopteris emarginata (Brack.) W.J. Robin.	'Uluhe, false staghorn fern	E	-	-	O	A	R	O	O	O	C
GRAMMITACEAE											
Adenophorus tamariscinus (Kaulf.) H. & Grev.	Wahine-noho-mauna	E	-	-	R	-	-	-	R	-	-
HEMIONITIDACEAE											
Pityrogramma calomelanos (L.) Link	Gold fern, silver fern	X	O	O	-	-	R	-	U	-	O
HYMENOPHYLLACEAE											
Gonocormus minutus (Blume) V.D. Bosh		I	-	-	R	-	-	-	-	-	-
Mecodium recurvum (Gaud.) Copel.	'Ohi'a-ku	E	-	-	R	-	-	-	R	-	-
Vandenboschia cyrtotheca (Hbd.) Copel.	Kilau	E	-	-	O	-	-	R	O	-	-

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
LINDSAEACEAE											
Sphenomeris chinensis (L.) Maxon	Pala'a	I	-	-	R	U	R	O	O	O	U
LYCOPODIACEAE											
Lycopodium cernuum L.	Wawae-iole	I	-	-	-	O	-	R	O	O	U
Lycopodium phyllanthum H. & A.	Wawae-iole	I	-	-	U	-	R	R	U	-	-
NEPHROLEPIDACEAE											
Nephrolepis cordifolia (L.) Presl	'Okupukupu	I	-	-	U	R	-	-	O	-	-
Nephrolepis exaltata (L.) Schott	Pamoho	I	-	-	O	U	-	-	O	O	-
Nephrolepis multiflora (Roxb.) Jarrett ex Morton	Hairy swordfern	X	-	-	-	U	A	-	C	O	O
OPHIOGLOSSACEAE											
Ophioglossum pendulum L.	Lau-kahi	I	-	-	O	R	-	O	O	O	-
POLYPODIACEAE											
Phymatosorus scolopendria (Burm.) Pichi Sermolli	Lau'ae	X	-	-	R	-	R	-	O	U	U
Pleopeltis thunbergiana Kaulf.	'Ekaha-'akolea	I	-	-	O	-	R	O	O	O	-
Polypodium pellucidum var. volcanicum Skottsb.	A'e	E	-	-	-	-	O	-	-	-	-

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
PSILOTACEAE											
Psilotum complanatum Sw.	Moa	I	-	-	R	-	-	-	U	-	-
Psilotum nudum (L.) Beauv.	Moa	I	-	-	O	R	R	-	O	O	-
PTERIDACEAE											
Pteris vittata L.	Kilau-o-pueo	X	-	-	-	-	U	-	-	-	U
SELAGINELLACEAE											
Selaginalla arbuscula (Kaulf.) Spring	Lepelepa-a-moa	E	-	-	U	-	-	R	U	-	-
THELYPTERIDACEAE											
Christella cyatheoides (Kaulf.) Holtt.	Kikawaio	E	-	-	U	-	-	-	-	-	-
Christella dentata (Forsk.) Brownsey & Jermy	Oak fern	X	-	O	O	R	-	O	C	O	O
Christella parasitica (L.) Levl.	Oak fern	X	-	-	-	-	-	-	O	-	-
Macrothelypteris torresiana (Gaud.) Ching		X	-	-	U	-	-	-	-	-	-
VITTARIACEAE											
Vittaria elongata Sw. (s.l.)	'Ohe'ohe	I	-	-	O	-	-	R	O	U	-

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
MONOCOTYLEDONS											
ARACEAE											
Colocasia esculenta var. antiquorum (Schott) Hubb. & Rehd.	Taro, kalo	P	U	-	R	-	-	-	-	R	R
Monstera deliciosa Liebm.	Monstera	X	-	-	-	-	-	-	-	R	-
Scindapsus aureus (Lind. ex Andre') Engl.	Taro vine	X	-	-	-	-	-	-	R	R	-
Syngonium auritum (L.) Schott	Syngonium	X	-	-	-	-	-	-	-	-	R
BROMELIACEAE											
Ananas comosus (Stickm.) Merr.	Pineapple, hala-kahiki	X	R	-	-	-	-	-	-	-	-
COMMELINACEAE											
Commelina diffusa Burm. f.	Honohono	X	-	O	-	-	-	-	O	O	O
CYPERACEAE											
Cyperus brevifolius (Rottb.) Hassk.	Kyllinga, kili'o'opu	X	O	U	-	-	-	R	-	-	O
Cyperus haspan L.		X	-	-	-	-	-	-	-	-	U
Cyperus javanicus Houtt.	'Ahu'awa, 'ehu'awa	I?	R	-	-	-	-	-	-	-	-
Cyperus polystachyus var. texensis (Torr.) Fern		I	-	-	-	-	-	-	-	-	R
Fimbristylis dichotoma (L.) Vahl	Tall fringe rush	I	O	-	-	-	-	-	-	-	O

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
CYPERACEAE (continued)											
Machaerina angustifolia (Gaud.) Koyama	'Uki	I	-	-	-	U	R	-	-	-	U
Machaerina mariscoides (Gaud.) Kern	'Uki, 'aha-niu	I	-	-	O	O	O	-	U	O	-
Rhynchospora lavarum Gaud.	Kuolohia, pu'uko'a	I	R	-	-	-	-	-	-	-	R
Scleria testacea Nees		E	-	-	-	-	-	-	-	R	-
DIOSCOREACEAE											
Dioscorea pentaphylla L.	Pi'ia	P	-	-	R	-	-	-	U	-	-
GRAMINEAE											
Andropogon glomeratus (Walt.) BSP.	Bush beardgrass	X	-	-	-	U	O	-	R	O	O
Andropogon virginicus L.	Broomsedge	X	-	-	O	O	C	-	R	O	A
Axonopus affinis Chase	Narrow-leaved carpetgrass	X	-	-	-	-	-	-	-	-	U
Axonopus compressus (Sw.) Beauv.	Broad-leaved carpetgrass	X	-	-	-	-	-	-	U	-	-
Bambusa sp. 1	Bamboo	X	L	-	-	-	-	-	L	-	L
Bambusa sp. 2	Bamboo	X	L	-	-	-	-	-	-	L	L
Brachiaria mutica (Forsk.) Stapf	Paragrass, Californiagrass	X	-	A	-	-	-	-	-	C	C
Brachiaria reptans (L.) Gard. & C.E. Hubb.		X	-	-	-	-	-	-	-	-	L
Chloris radiata (L.) Sw.	Radiate fingergrass	X	U	-	-	-	-	-	-	-	-

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
GRAMINEAE (continued)											
Coix lachryma-jobi L.	Job's tears, 'ohe pu'ohe'ohe	X	U	-	-	-	-	-	-	-	U
Digitaria adscendens (HBK.) Henr.	Henry's crabgrass	X	-	-	-	-	-	-	-	-	U
Digitaria eriantha Steud.		X	-	-	-	-	-	-	-	-	L
Digitaria pruriens (Fisch. ex Trin.) Buse	Itchy crabgrass	X	O	O	-	-	-	-	-	-	U
Digitaria violascens Link	Kukaipua'a-uka	X	-	-	-	-	-	-	-	U	O
Eleusine indica (L.) Gaertn.	Goosegrass, manienie-ali'i	X	U	-	-	-	-	-	-	R	O
Eragrostis sp.		X	-	-	-	-	-	-	-	U	O
Hyparrhenia rufa (Nees) Stapf	Thatchinggrass, jaragua	X	-	-	-	-	-	-	-	-	R
Melinis minutiflora Beauv.	Molassesgrass	X	O	C	O	U	R	-	O	C	C
Oplismenus hirtellus (L.) Beauv.	Basketgrass, honohono-kukui	X	-	-	O	-	-	O	C	C	U
Panicum maximum Jacq.	Guinea grass	X	-	-	-	-	-	-	-	U	-
Paspalum conjugatum Berg.	Hilo grass, mau'u-Hilo	X	O	-	O	-	-	C	C	C	C
Paspalum orbiculare Forst. f.	Ricegrass, mau'u-laiki	X	O	-	-	R	-	-	R	U	O
Paspalum urvillie Steud.	Vaseygrass	X	-	-	-	-	-	-	-	-	U
Pennisetum purpureum Schumach.	Elephantgrass, napiergrass	X	-	C	-	-	-	-	-	C	O
Poa annua L.	Annual bluegrass	X	-	-	-	-	-	-	-	-	U
Saccharum officinarum L.	Sugar cane, ko	P	O	O	-	-	-	-	R	U	O
Sacciolepis indica (L.) Chase	Glenwoodgrass	X	-	R	U	-	-	-	C	O	O
Schizostachyum glaucifolium (Rupr.) Munro	Ohe	P	-	-	L	-	-	-	L	L	R
Setaria geniculata (Poir.) Beauv.	Perennial foxtail	X	-	-	-	-	-	-	O	O	O

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
GRAMINEAE (continued)											
Setaria glauca (L.) Beauv.	Yellow foxtail	X	O	-	O	-	-	-	-	O	-
Setaria palmaefolia (Koen.) Stapf	Palmgrass	X	-	-	-	-	-	-	-	-	R
Sporobolus africanus (Poir.) Robyns & Tournay	African dropseed	X	-	-	-	-	-	-	-	U	U
LILIACEAE											
Cordyline terminalis (L.) Kunth	Ti, ki	P	O	R	U	U	-	O	O	O	O
Cordyline terminalis var. ferrea (L.) J. G. Baker	Red ti	X	-	-	-	-	-	-	-	R	R
MARANTACEAE											
Calathea ornata (Lem.) Koern.		X	-	-	-	-	-	-	R	-	-
MUSACEAE											
Musa X nana Lour.	Chinese banana	X	O	U	-	-	-	-	-	-	-
Musa X paradisiaca L.	Banana, mai'a	P	O	U	R	-	-	-	R	-	R
ORCHIDACEAE											
Arundina bambusaefolia (Roxb.) Lindl.	Bamboo orchid	X	-	-	U	O	O	O	O	O	C
Phaius tankervilliae (Banks ex L'He'r.) Bl.		X	-	-	R	-	-	R	R	-	-

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
ORCHIDACEAE (continued)											
Spathoglottis plicata Bl.	Chinese orchid	X	-	-	U	O	O	O	O	O	O
Vanda teres Lindl. X V. hookeriana Reichb. f.	Vanda "Miss Joaquim"	X	U	-	-	-	-	-	-	-	-
PALMAE											
Cocos nucifera L.	Coconut, niu	P	-	U	-	-	-	-	-	U	U
PANDANACEAE											
Freycinetia arborea Gaud.	Ie'ie	E	-	-	C	O	-	O	O	-	-
Pandanus odoratissimus L. f.	Hala, pandauus	I	-	-	-	U	-	O	-	U	-
ZINGIBERACEAE											
Alpinia purpurata (Vieill.) K. Schum.	Red ginger, 'awapuhi-'ula'ula	X	-	R	-	-	-	-	-	-	-
Hedychium flavescens Carey	Yellow ginger; 'awapuhi-melemele	X	-	-	R	-	-	-	-	O	U
Zingiber zerumbet (L.) Roscoe	'Awapuhi kua hiwi	P	-	-	U	-	-	O	U	-	-
DICOTYLEDONS											
ACANTHACEAE											
Odontonema strictum (Nees) Ktze.	Odontonema	X	-	-	-	-	-	-	-	R	-
Thunbergia fragrans Roxb.	White thunbergia	X	O	C	U	-	-	-	O	U	U

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
ANACARDIACEAE											
Mangifera indica L.	Mango, manako	X	-	-	-	R	-	-	-	O	O
Schinus terebinthifolius Raddi	Christmas berry, nani-o-Hilo	X	-	-	-	-	-	-	-	U	-
APOCYNACEAE											
Alyxia olivaeformis Gaud.	Maile	E	-	-	U	-	-	R	-	-	-
AQUIFOLIACEAE											
Ilex anomala H. & A.	Kawa'u, ka'awa'u	E	-	-	-	-	-	U	-	-	-
ARALIACEAE											
Brassaia actinophylla Endl.	Octopus tree	X	-	-	-	-	-	-	-	R	-
Tetraplasandra hawaiiensis Gray	'Ohe	E	-	-	U	-	-	U	-	-	-
ASCLEPIADACEAE											
Asclepias curassavica L.	Butterflyweed, lau-lele	X	-	-	-	R	-	-	R	-	-
BALSAMINACEAE											
Impatiens sultani Hook. f.	Impatiens	X	-	-	R	-	-	-	R	U	R
BEGONIACEAE											
Begonia sp.	Begonia	X	-	U	U	-	-	-	O	U	U

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
BIGNONIACEAE											
Spathodea campanulata Beauv.	African tulip tree	X	-	R	-	-	-	-	R	-	-
BIXACEAE											
Bixa orellana L.	Arnotto, lipstick plant	X	R	-	-	-	-	-	-	-	-
CARICACEAE											
Carica papaya L.	Papaya, mikana	X	A	-	-	-	-	-	R	U	-
CARYOPHYLLACEAE											
Drymaria cordata (L.) Willd. ex R. & S.	Drymaria, pipili	X	-	-	-	-	-	-	-	U	O
CASUARINACEAE											
Casuarina equisetifolia Stickm.	Ironwood	X	-	-	-	R	-	-	-	-	-
CELASTRACEAE											
Perrottetia sandwicensis Gray	Olomea, pua'a olomea	E	-	-	-	-	-	-	U	-	-
COMPOSITAE											
Ageratum conyzoides L.	Ageratum	X	O	O	-	R	R	-	U	U	O
Bidens pilosa L.	Beggar's tick, Spanish needle	X	-	-	-	R	-	-	-	R	U
Crepis sp.		X	-	-	R	-	-	-	-	-	-

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
COMPOSITAE (continued)											
Eclipta alba (L.) Hassk.	False daisy	X	R	R	-	-	-	-	-	-	-
Emilia fosbergii Nicolson	Pua-lele	X	O	-	-	-	R	-	-	-	O
Emilia sonchifolia (L.) DC.	Lilac pua-lele	X	O	-	-	-	-	-	-	-	U
Erechtites hieracifolia (L.) Raf.	Fireweed	X	O	O	O	-	U	U	-	O	O
Erigeron canadensis L.	Canada fleabane, ilioha	X	-	-	R	R	R	-	-	-	O
Eupatorium riparium Regel	Pamakani	X	-	-	-	R	-	-	R	-	O
Pluchea odorata (L.) Cass.	Pluchea, shrubby fleabane	X	C	C	O	O	U	U	U	O	C
Sonchus oleraceus L.	Sow thistle, pua-lele	X	-	-	R	-	R	-	-	-	R
Vernonia cinerea (L.) Less.	Ironweed	X	-	U	-	-	R	-	-	-	R
Wedelia trilobata (L.) Hitchc.	Wedelia	X	-	-	-	-	-	-	-	R	U
Youngia japonica (L.) DC.	Oriental hawksbeard	X	R	-	R	-	R	-	R	U	-
CONVOLVULACEAE											
Ipomoea batatas (L.) Poir.	'Uala, sweet potato	P	U	R	-	-	-	-	-	-	-
Ipomoea congesta R. Br.	Koali-'awania	I	-	R	-	-	-	-	-	-	-
Ipomoea triloba L.	Little bell	X	-	-	-	-	-	-	-	-	R
Ipomoea sp.		X	-	R	-	-	-	-		-	-
Merremia tuberosa (L.) Rendle	Wood rose	X	-	-	-	-	-	-	-	R	-
CRASSULACEAE											
Kalanchoe pinnata (Lam.) Pers.	Air plant, 'oliwa-ku-kahakai	X	-	-	-	-	-	-	-	-	R

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
CRUCIFERAE											
Cardamine flexuosa f. umbrosa (Gren. & Godr.) O.E. Schulz	Bitter-cress	X	R	-	-	-	-	-	-	-	-
Nasturtium sarmentosum (DC.) Schinz & Guillaumin	Pa'ihi,'ihi-ku-kepau	P	U	-	-	-	-	-	-	-	-
CUCURBITACEAE											
Momordica charantia var. paval Crantz	Balsam apple, peria	X	R	-	-	-	-	-	-	-	-
EBENACEAE											
Diospyros ferrea subsp. sandwicensis (A. DC.) Fosb.	Lama	E	-	-	O	C	-	A	O	O	-
EPACRIDACEAE											
Styphelia tameiameiae (Cham.) F. Muell.	Pukiawe, maiele	I	-	-	-	U	O	-	-	-	U
EUPHORBIACEAE											
Aleurites moluccana (L.) Willd.	Kukui, tutui, candlenut tree	P	-	-	U	U	-	-	O	-	O
Antidesma platyphyllum Mann	Hame	E	-	-	U	-	-	R	U	-	-
Euphorbia glomerifera (Millsp.) L. C. Wheeler		X	O	-	-	-	-	-	-	-	O

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
EUPHORBIACEAE (continued)											
Euphorbia hirta L.	Garden spurge, hairy spurge	X	O	O	-	-	R	-	-	U	O
Euphorbia prostrata Ait.	Prostrate spurge	X	O	-	-	-	-	-	-	R	O
Euphorbia thymifolia L.	Thyme-leaved spurge	X	U	-	-	-	-	-	-	-	-
Euphorbia sp.		X	O	-	-	-	-	-	-	-	-
Manihot esculenta Crantz	Cassava, manioka, tapioca	X	-	-	-	-	-	-	-	R	-
Manihot glaziovii Muell.-Arg.	Ceara' rubber	X	-	-	-	-	-	-	-	U	-
Phyllanthus debilis Klein ex Willd.	Phyllanthus weed	X	-	-	-	-	R	-	-	R	-
Ricinus communis L.	Castor bean, koli	X	-	R	-	-	-	-	-	-	-
GESNERIACEAE											
Cyrtandra paludosa var. integrifolia Hbd.		E	-	-	R	-	-	R	R	-	-
Cyrtandra paludosa var. irrostrata St. John		E	-	-	R	-	-	R	R	-	-
Cyrtandra sp.		E	-	-	R	-	-	-	R	-	-
GOODENIACEAE											
Scaevola taccada (Gaertn.) Roxb.	Naupaka-kahakai	I	-	-	-	R	-	-	-	-	-
LABIATAE											
Coleus blumei Benth.	Coleus, weleweka	X	-	-	-	-	-	-	-	U	-
Hyptis pectinata (L.) Poit.	Comb hyptis	X	O	O	R	-	R	-	R	O	O

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
LAURACEAE											
Cassytha filiformis L.	Kaunoa'oa, kaua'oa-pehu	I	-	U	-	-	-	-	-	-	-
Persea americana Mill.	Avocado	X	O	-	R	R	-	-	-	O	R
LEGUMINOSAE											
Albizia falcataria (L.) Fosb.	Albizia	X	-	U	-	R	U	-	-	C	O
Canavalia ensiformis (L.) DC.	Jack bean	X	-	R	-	-	-	-	-	-	-
Cassia alata L.	Candlebush	X	-	-	-	-	-	-	-	-	R
Cassia leschenaultiana DC.	Partridge pea, lauki	X	O	-	-	R	R	-	-	U	O
Crotalaria incana L.	Fuzzy rattle-pod, kukai-hoki	X	-	-	-	-	-	-	-	R	O
Crotalaria mucronata Desv.	Mucronate crotalaria	X	-	R	-	-	-	-	-	-	U
Crotalaria retusa L.	Rattle-box, sauni	X	-	-	-	-	R	-	-	-	-
Crotalaria sp.		X	-	-	-	-	U	-	-	R	U
Desmondium cajanifolium (HBK.) DC.	Tall desmodium	X	C	A	-	-	R	-	-	U	C
Desmodium canum (Gmel.) Schinz & Thell.	Ka'imi	X	-	O	-	-	-	-	-	-	O
Desmodium triflorum (L.) DC.	Three-flowered beggarweed	X	-	-	-	-	-	-	-	U	O
Desmodium uncinatum (Jacq.) DC.	Spanish clover	X	O	C	-	O	R	O	O	O	C
Desmodium sp.		X	C	A	-	-	-	-	-	O	O
Indigofera suffruticosa Mill.	Indigo, 'iniko	X	U	U	-	-	R	-	-	-	O
Leucaena leucocephala (Lam.) de Wit	Koa-haole	X	-	-	-	-	-	-	-	U	U
Mimosa pudica var. unijuga (Duchass. & Walp.) Griseb.	Sensitive plant, pua-hilahila	X	O	C	-	R	R	-	-	O	C

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
LEGUMINOSAE (continued)											
Mucuna gigantea (Willd.) DC.	Ka'e'e, sea bean	I	-	-	-	-	-	-		R	-
Phaseolus atropurpureus DC.	Siratro	X	-	-	-	-	-	-	-	-	O
Phaseolus vulgaris L.	String bean	X	U	-	-	-	-	-	-	-	-
Samanea saman (Jacq.) Merr.	Monkeypod	X	-	-	-	-	-	-	-	U	R
LOGANIACEAE											
Buddleja asiatica Lour.	Asiatic butterfly bush	X	O	C	R	-	O	-	U	O	O
LYTHRACEAE											
Cuphea carthagenensis (Jacq.) Macbride	Columbian cuphea, puakamoli	X	R	R	-	-	-	-	-	-	O
Lythrum maritimum HBK.	Puakamole	X	-	-	-	-	-	-	-	R	-
Indet.		X	R	-	-	-	-	-	-	-	-
MALVACEAE											
Hibiscus esculentus L.	Okra, gumbo	X	R	-	-	-	-	-	-	-	-
Hibiscus rosa-senensis L.	Red hibiscus	X	-	-	-	-	-	-	-	-	R
Hibiscus youngianus Gaud. ex H. & A.	Hau-hele, 'akiohala	E	-	R	-	-	-	-	-	-	-
Sida rhombifolia L.	Cuba jute	X	-	-	-	R	-	-	-	R	U

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
MELASTOMATACEAE											
Clidemia hirta (L.) D. Don	Koster's curse, clidemia	X	-	-	R	-	-	-	-	-	R
Dissotis plumosa Hook. f.	Dissotis	X	R	-	-	-	-	-	-	-	R
Melastoma malabathricum L.	Malabar melastome	X	-	-	O	C	-	O	O	C	C
Pterolepis sp.		X	-	R	R	-	-	-	-	-	U
MENISPERMACEAE											
Cocculus ferrandianus Gaud.	Huehue, hue'ie	E	-	-	O	U	-	-	-	O	U
MORACEAE											
Cannabis sativa L.	Marijuana, pot, pakalolo	X	-	-	R	R	-	-	-	-	-
Cecropia obtusifolia Bertol.	Guarumo	X	-	-	O	U	-	-	U	O	-
Ficus microcarpa L. f.	Chinese banyan	X	-	-	-	-	-	-	-	R	-
MORINGACEAE											
Moringa oleifera Lam.	Horseradish tree	X	-	R	-	-	-	-	-	-	-
MYRSINACEAE											
Myrsine lessertiana A. DC.	Kolea-lau-nui	E	-	-	O	O	-	O	O	-	-
MYRTACEAE											
Eugenia cuminii (L.) Druce	Java plum, palama	X	-	-	-	-	-	-	-	-	R
Eugenia jambos L.	Rose apple, 'ohi'a-loke	X	-	-	-	R	-	-	-	C	-

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
MYRTACEAE (continued)											
Metrosideros polymorpha Gaud.	'Ohi'a, 'ohi'a-lehua	E	-	R	A	A	A	A	A	C	O
Psidium cattleianum f. cattleianum Sabine	Strawberry guava	X	-	R	C	-	-	O	A	C	C
Psidium cattleianum f. lucidum Degener	Yellow strawberry guava, waiawi	X	-	-	-	-	-	-	U	-	-
Psidium guajava L.	Guava, kuawa	X	-	U	O	O	-	O	C	C	O
NYCTAGINACEAE											
Pisonia umbellifera (J.R. & G. Forst.) Seem.	Papala-kepau	E	-	-	-	-	-	-	R	-	-
ONAGRACEAE											
Ludwigia octivalvis (Jacq.) Raven	Primrose willow, kamole	I	R	R	-	-	-	-	-	-	-
OXALIDACEAE											
Oxalis corniculata L.	Yellow wood sorrel, 'ihi	I	O	-	-	-	-	-	-	U	-
Oxalis maritiana Zucc.	Pink wood sorrel, 'ihi pehu	X	O	-	-	-	-	R	-	-	U
PASSIFLORACEAE											
Passiflora edulis f. flavicarpa Degener	Yellow liliko'i	X	-	-	-	-	-	-	R	U	R
Passiflora foetida L.	Scarlet-fruited passionflower	X	U	-	R	-	-	R	-	U	-

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
PIPERACEAE											
Peperomia leptostachya H. & A.	Kupali'i	I	-	-	U	-	-	-	U	-	-
PLANTAGINACEAE											
Plantago major L.	Common plantain, lau-kahi	X	-	-	-	R	-	-	-	U	-
POLYGALACEAE											
Polygala paniculata L.	Polygala	X	C	O	-	R	R	-	-	U	O
POLYGONACEAE											
Polygonum capitatum Ham. ex Don	Polygonum	X	-	-	-	-	-	-	-	-	U
PROTEACEAE											
Macadamia ternifolia var. integrifolia (Maiden & Betche) Maiden & Betche	Macadamia nut	X	O	-	-	-	-	-	-	-	-
ROSACEAE											
Rubus rosaefolius Sm.	Thimbleberry	X	-	R	U	-	-	O	O	O	U
RUBIACEAE											
Bobea sp.	'Ahakea	E	-	-	-	-	-	-	R	-	-
Borreria laevis (Lam.) Griseb.	Buttonweed, spermacoce	X	U	-	-	-	-	-	-	R	-

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
RUBIACEAE (continued)											
Borreria sp.		X	C	O	-	R	R	-	-	R	O
Hedyotis corymbosa (L.) Lam.		X	O	-	-	-	-	-	-	R	O
Morinda citrifolia L.	Noni	P	-	-	R	-	-	-	-	-	-
Paederia foetida L.	Maile pilau	X	-	O	O	-	-	-	O	O	O
Psychotria hawaiiensis (Gray) Fosb.	Kopiko	E	-	-	C	O	-	O	O	O	U
SCROPHULARIACEAE											
Castilleja arvensis Schlecht. & Cham.	Field Indian paintbrush	X	O	-	R	R	-	-	-	-	O
Lindernia crustacea (L.) F. Muell.	Lindernia, false pimpernel	X	O	-	-	-	-	-	-	U	O
Lindernia sp.		X	O	-	-	-	-	-	-	-	-
SOLANACEAE											
Lycopersicon pimpinellifolium Mill.	Currant tomato, 'ohi'a-ma-kanahele	X	-	U	-	-	-	-	-	-	
Solandra hartwegi N.E. Br.	Cup of gold	X	-	-	-	-	-	-	-	-	R
Solanum melongena var. serpentinum (Noronha) Bailey	Long eggplant	X	U	-	-	-	-	-	-	-	-
Solanum nigrum L.	Black nightshade, popolo	I?	-	-	-	-	-	-	-	R	O
STERCULIACEAE											
Melochia umbellata (Houtt.) Stapf	Melochia	X	O	O	-	U	-	-	U	C	O
Waltheria indica var. americana (L.) R. Br. ex Hosaka	Hi'aloa, 'uhaloa	I	-	-	-	-	R	-	-	-	U

TAXA	COMMON NAME	STATUS	1	2	3	4	5	6	7	8	9
THYMELAEACEAE											
Wikstroemia sandwicensis Meisn.	'Akia	E	-	-	U	U	-	O	-	U	-
ULMACEAE											
Trema orientalis (L.) Bl.	Gunpowder tree	X	O	-	-	-	-	R	-	O	O
UMBELLIFERAE											
Centella asiatica (L.) Urban	Asiatic pennywort, pohekula	X	O	-	-	R	-	-	-	O	O
URTICACEAE											
Pipturus hawaiensis Levl.	Mamaki	E	U	-	O	-	R	-	O	O	O
Touchardia latifolia Gaud.	Olona	E	-	-	R	-	-	-	-	-	-
VERBENACEAE											
Lantana camara L.	Lantana, lakana	X	-	-	R	R	-	-	-	-	-
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, owi, oi	X	O	O	R	R	-	O	O	O	O
Verbena litoralis HBK.	Weed verbena, ha'uowi	X	O	R	R	-	-	-	-	U	O

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